REMARKS

The Office Action mailed July 3, 2001, has been reviewed and the comments of the Patent and Trademark Office have been considered. Claims 1, 4-7, 13, 16, 19, 28 and 29 have been amended. New claims 30-36 have been added. Claims 3 and 11 have been cancelled. Claims 1-2, 4-10 and 12-36 are pending for consideration.

Drawings

The drawings were objected to. With respect to Figure 20, applicants have amended the specification to describe step P308. With respect to Figure 22, applicants propose to amend that figure in the Proposed Changes to the Drawings, submitted herewith, as suggested by the Examiner. Specifically, the reference numeral "P509" has been replaced with "P504". Applicants submit that the objection to the drawings has been overcome and respectfully request that the objection be withdrawn.

Abstract and Specification

The abstract has been amended to replace the phrase "comprise" with "include". The specification has been amended as suggested by the Examiner. Accordingly, applicants respectfully request that the objections to the abstract and the specification be withdrawn.

Objections to the claims

Claim 16 was objected to. Applicants have amended claim 16 as suggested by the Examiner. Accordingly, applicants submit that the objection to claim 16 has been overcome, and respectfully request that the objection be withdrawn.

Allowable subject matter

Applicants appreciate the indication that claims 19-22 contain allowable subject matter. Applicants have amended claim 19 to be in independent form including all the

limitations from its original independent claim 1 and some, but not all, of the limitations from any intervening claims. Applicants submit that claim 19, as amended, and claims 20-22 which depend ultimately therefrom, are allowable.

Rejections under 35 U.S.C. §§ 102 and 103

Claims 1-3, 7, 8, 10, 11, 13, 14 and 26-29 stand rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,412,946 to Oshima et al. (hereafter "Oshima"). Claims 4-6, 9, 12, 15-18 and 23-25 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ohshima in view of various different references including U.S. Patent No. 6,244,044 to Bartley (hereafter "Bartley"), U.S. Patent No. 6,151,547 to Kumar et al. (hereafter "Kumar"), U.S. Patent No. 5,124,303 to Kobayashi et al. (hereafter "Kobayashi"), U.S. Patent No. 4,149,998 to Tauster et al. (hereafter "Tauster"), U.S. Patent No. 6,165,633 to Negishi (hereafter "Negishi"), U.S. Patent No. 6,122,909 to Murphy et al. (hereafter "Murphy"), and U.S. Patent No. 6,173,571 to Kaneko et al. (hereafter "Kaneko"). In sum, claims 1-18 and 23-29 stand rejected over Ohshima alone, or over Oshima in view of other references. Applicants respectfully traverse these rejections, insofar as they pertain to the claims as presently amended, for the following reasons.

Claims 1, 28 and 29

Independent claim 1 has been amended to include some of the limitations from original claim 3, now cancelled. Specifically claim 1 includes the limitation of "wherein said hydrogen enriching device is at least one selected from the group consisting of a device for producing hydrogen in at least one of combustion gas and exhaust gas, a device for decreasing the reducing components other than hydrogen in at least one of combustion gas and exhaust gas, and a device for suppressing consumption of hydrogen in at least one of combustion gas and exhaust gas." Thus, in independent claim 1, hydrogen is produced, its consumption is suppressed, or reducing components other than hydrogen are decreased <u>in at</u> 1 ← response

least one of a combustion gas or exhaust gas. Independent claims 28 and 29 contain limitations corresponding to the limitation added to claim 1. Applicants submit that Oshima fails to suggest this feature of claims 1, 28 and 29 because Oshima discloses that the hydrogen is generated directly and exclusively from fuel or an uncombusted air-fuel mixture, and not from either a combustion gas or an exhaust gas.

More specifically, Oshima discloses producing hydrogen using fuel from an engine. For example, the embodiment of Fig. 1 illustrates fuel from fuel conduit 104 passing to the reforming catalytic converter 102 that acts to generate H_2 (See Fig. 1, col. 5, lines 33-36, 48-51, col. 5, line 65 - col. 6, line 3). Likewise in the embodiments of Fig. 6 (col. 7, lines 1-6) and Fig. 9 (col. 7, lines 65-66) fuel is supplied directly to the hydrogen generator. In all three embodiments of Figs. 1, 6, and 9 the hydrogen is generated from fuel, not from gases in the exhaust conduit.

Furthermore, the hydrogen is not generated in situ in either the combustion gases or exhaust gases of the system. In the embodiment of Fig. 1, the converter 102 (which generates hydrogen) is not disposed in the exhaust conduit 101 so the hydrogen is not generated in the combustion gas or exhaust gases per se. In the embodiment of Fig. 6, the coiled tube 114 of the hydrogen generator 11 is disposed in the exhaust conduit (see Fig. 7), but the tube is sealed from the exhaust gas and thus hydrogen is not generated in the presence (e.g., in situ) of either combustion gas or exhaust gas. Similarly in the embodiment of Fig. 9, hydrogen is not generated in the presence of either combustion gas or exhaust gas. Thus, Oshima does not disclose the limitation of independent claims 1, 28 or 29 where hydrogen is produced, its consumption is suppressed, or reducing components other than hydrogen are decreased in at least one of a combustion gas or exhaust gas.

Claims 7 and 13.

Claim 7 has been amended to be in independent form and to include the limitations from original claim 1, but not all of the limitations from original intervening claim 3. Claim 7 has also been amended to clarify that the device for supplying hydrogen contained gas includes the combustion device and the hydrogen is generated in the combustion device. Independent claim 13, as amended includes a similar limitation where hydrogen is generated in the engine. Applicants submit that Oshima does not suggest that hydrogen is generated in a combustion device. In all three embodiments of Oshima (Figs. 1, 6 and 9), the hydrogen generator is not within the engine, i.e., a combustion device, and Oshima does not disclose that the hydrogen generator is such a combustion device.

restrict

Claim 30

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New independent claim 30 has been added. Claim 30 is similar to original claim 1, but includes the additional limitation of "wherein said hydrogen enriching device produces hydrogen out of at least one of combustion gas and exhaust gas." As discussed above, Oshima does not suggest generating hydrogen out of combustion gas or exhaust gas, but instead teaches that fuel should be directly used in generating hydrogen, and thus Oshima does not suggest the invention of claim 30.

← response

Claim 33

New independent claim 33 has been added. Claim 33 is similar to original claim 1, but additionally includes limitations from original claim 18. Specifically, new claim 33 includes the limitation of "wherein the hydrogen producing catalyst produces hydrogen from HC and CO in at least one of combustion gas and exhaust gas." As discussed above with respect to claim 30, Oshima discloses that hydrogen is generated by introducing fuel into a hydrogen generating device. Thus in contrast to the present invention of claim 33, Oshima does not disclose that hydrogen is produced from "HC and CO in at least one of combustion gas and exhaust gas."

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Claim 35

New claim 35 recites an arrangement where both the NOx treating catalyst and the hydrogen enriching device are disposed in the exhaust gas passageway and the exhaust gas passes through the hydrogen enriching device. Applicants submit that Oshima fails to suggest the arrangement of claim 35, where both the NOx treating catalyst and the hydrogen enriching device are disposed in the exhaust gas passageway in a manner wherein the exhaust gas passes through the hydrogen enriching device.

In Oshima the exhaust gas does not pass through the hydrogen generator. In the embodiment of Fig. 1, the converter 102 (which generates hydrogen) is not disposed in the exhaust conduit 101 such that exhaust gas would pass through the converter 102. In the embodiment of Fig. 6, the coiled tube 114 of the hydrogen generator 11 is in the exhaust conduit (see Fig. 7), but the exhaust gas does not pass through the coiled tube. Finally, in the embodiment of Fig. 9, the exhaust gas does not pass through the hydrogen generator. Thus, Oshima does not disclose or suggest the arrangement of claim 35, where both the NOx treating catalyst and the hydrogen enriching device are disposed in the exhaust gas passageway and the exhaust gas passes through the hydrogen enriching device.

For the reasons given above, applicants submit that claims 1-2, 4-10 and 12-36 are patentable over the art cited in the rejections under 35 U.S.C. 102 or 35 U.S.C. 103. Accordingly, applicants respectfully request that the rejection of the claims under 35 U.S.C. 102 or 35 U.S.C. 103 be withdrawn.

USSN 09/692,470

Attorney Docket No. 040679-1154

CONCLUSION

In view of the foregoing amendments and remarks, applicants respectfully submit that all of the pending claims are now in condition for allowance. An early notice to this effect is earnestly solicited. If there are any questions regarding the application, the Examiner is invited to contact the undersigned at the number below.

Respectfully submitted,

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002.681232.1

Versions with Markings to Show Changes Made

In the Specification:

Paragraph beginning on page 1 at line 28 has been amended as follows:

However, in such techniques using the three-way catalyst or disclosed in Japanese Patent No. 2600492, it is required to periodically or intermittently supply HC and CO as a reducing agent (reducing component or gas) to promote reduction of NOx. In this connection, HC and CO which has not been consumed in the NOx reduction reaction is required to be oxidized. This will be accomplished by a measure of oxidizing HC and CO by making oxidation reaction simultaneously on the NOx treating catalyst, or another measure of oxidizing excessive HC and CO in a three-way catalyst or the like disposed downstream of the NOx treating catalyst.

Paragraph beginning on page 28 at line 26 has been amended as follows:

Activated alumina powder was impregnated with an aqueous solution of palladium nitrate containing a certain amount of palladium, and then dried at 150 °C for 12 hours. Thereafter, the thus impregnated activated alumina powder was fired 400 °C for 1 hour thereby to form Pd-carried alumina powder (Powder A) whose [cocentration] concentration of Pd carried was 15.0% by weight.

Paragraph beginning on page 57 at line 19 has been amended as follows:

At the step P302, an engine air-fuel ratio control flag is set. When this [flat] flag is set, the fuel injection amount is controlled in such a manner that the air-fuel ratio of air-fuel mixture to be supplied to the engine becomes rich, under a fuel injection control routine (not shown) executed by the electronic control unit (like that shown in Fig. 2). Accordingly, the air-fuel ratio of exhaust gas to be flown to the NOx trap agent in the catalyst 2 is changed to a rich side (richer than the stoichiometric value).

Paragraph beginning on page 58 at line 5 has been amended as follows:
At a step P305, increment of 1 is made on a count value C for setting the NOx treatment flag. At a step P306, judgement is made as to whether the count value C becomes larger than a certain value C0. When C $\leq$ C0, the flow of the processing routine is completed. When C > CO, the flow goes to a step P307 at which the NOx treatment flag is reset. When the NOx treatment flag is reset, supply of hydrogen-contained gas is terminated, so that the air-fuel ratio of exhaust gas to be flown into the NOx treating catalyst 2 is restored to the state of being lean (which is the same as that before setting the NOx treatment flag), thus terminating this routine. <u>At step P308, the count value C and the accumulated value of the engine speed Σ NE are set to zero.</u>

In the Claims:

Please amend claims 1, 4-7, 13, 16, 19, 28 and 29 as follows:

1. (Once Amended) An exhaust gas purifying system comprising:

a NOx treating catalyst for reducing NOx disposed in an exhaust gas passageway of a combustion device, to reduce NOx in presence of reducing components in exhaust gas; and

a hydrogen enriching device disposed upstream of said NOx treating catalyst with respect to flow of exhaust gas from the combustion device and arranged to increase a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas so as to meet relations represented by following formulae (1) and (2), when reduction of NOx is carried out by said NOx treating catalyst:

1026 $[H2 / TR]d > [H2 / TR]u$ ...(1)

Oshima $[H2 / TR]d \geq 0.3$ ...(2)

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas passageway upstream of said hydrogen enriching device and combustion gas in a state

before undergoing the hydrogen ratio increasing by said hydrogen enriching [means] device; and [H2 / TR]d is a ratio between a concentration [H2]d of hydrogen and a concentration [TR]d of total reducing components in exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and downstream of said hydrogen enriching device,

(a) ~~Fig 2~~ 18

generic

wherein said hydrogen enriching device is at least one selected from the group consisting of a device for producing hydrogen in at least (engine) one of combustion gas and exhaust gas, a device for decreasing the reducing components other than hydrogen in at least one of combustion gas and exhaust gas, and a device for suppressing consumption of hydrogen in at least one of combustion gas and exhaust gas.

claim 2 generic

4. (Once Amended) An exhaust gas purifying system as claimed in claim [3] 1, wherein the device for producing hydrogen in at least one of combustion gas and exhaust gas includes at least one selected from the group consisting of a hydrogen producing catalyst containing at least one noble metal, and a combustion control device for controlling at least one selected from the group consisting of operating parameters of an internal combustion engine and combinations of the operating parameters, the operating parameters including fuel injection timing, spark timing, opening and closing timings of intake and exhaust valves of the internal combustion engine.

not generic — Fig ~~7~~ ~~18~~ 18 — Fig 2 or 18

5. (Once Amended) An exhaust gas purifying system as claimed in claim [3] 1, wherein the device for decreasing the reducing components other than hydrogen in at least one of combustion gas and exhaust gas includes a CO and HC selective oxidation catalyst containing zirconium oxide, for selectively [oxidize] oxidizing CO and HC.

not generic — fig. 2 ~~15A~~

6. (Once Amended) An exhaust gas purifying system as claimed in claim [3] 1,

wherein the device for suppressing consumption of hydrogen in at least one of combustion gas and exhaust gas is a catalyst containing solid acid zirconium oxide.

not generic — Fig. 2

7. (Once Amended) [An exhaust purifying system as claimed in claim 3] An exhaust gas purifying system comprising:

a NOx treating catalyst for reducing NOx disposed in an exhaust gas passageway of a combustion device, to reduce NOx in presence of reducing components in exhaust gas; and

a hydrogen enriching device disposed upstream of said NOx treating catalyst with respect to flow of exhaust gas from the combustion device and arranged to increase a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas so as to meet relations represented by following formulae (1) and (2), when reduction of NOx is carried out by said NOx treating catalyst:

[H2 / TR]d > [H2 / TR]u ...(1)

[H2 / TR]d ≥ 0.3 ...(2)

not generic

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas passageway upstream of said hydrogen enriching device and combustion gas in a state before undergoing the hydrogen ratio increasing by said hydrogen enriching device; and [H2 / TR]d is a ratio between a concentration [H2]d of hydrogen and a concentration [TR]d of total reducing components in exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and downstream of said hydrogen enriching device, Fig 3+4

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wherein the hydrogen enriching device is a device for introducing hydrogen into at least one of combustion gas and exhaust gas [is a device] and for supplying hydrogen-contained gas produced by using hydrocarbon fuel and air, from outside of the exhaust passageway, and wherein the hydrogen contained gas is produced in ~~the~~ a combustion device.

112 paragraph

13. (Once Amended) An exhaust gas purifying system of a multiple step control type in combination with an internal combustion engine having an exhaust gas passageway, Fig 3+4

Same as claim 7

not generic

claim 8, 9, 10, ~~11~~, 12 } depend on claim 7 not generic

said engine [includes] including a combustion system having a combustion control device for controlling at least one selected from the group consisting of operating parameters of the engine and combinations of the operating parameters, the operating parameters including fuel injection timing, spark timing, opening and closing timing of intake and exhaust valves of the engine;

said exhaust gas purifying system including

a NOx treating catalyst for reducing NOx disposed in the exhaust gas passageway to reduce NOx in presence of reducing components in exhaust gas, and a hydrogen enriching device disposed upstream of said NOx treating catalyst with respect to flow of exhaust gas and including at least one selected from the group consisting of a hydrogen producing catalyst containing at least one noble metal, a CO and HC selective oxidation catalyst containing zirconium oxide, a catalyst containing solid acid zirconium oxide, and a device for supplying hydrogen-contained gas produced by using hydrocarbon fuel and air, from outside of the exhaust passageway, said hydrogen-contained gas supplying device including at least one of a first hydrogen-contained gas supplying device having a hydrogen-contained gas producing catalyst for promoting reaction for producing hydrogen-contained gas from the hydrocarbon fuel, and a device for supplying the hydrocarbon fuel and air to the catalyst, and a second hydrogen-contained gas supplying device for producing hydrogen-contained gas by using hydrocarbon fuel and exhaust gas under heat,

said hydrogen enriching device being arranged to increase a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas so as to meet relations represented by the following formulae (1) and (2), when reduction to NOx is carried out by said NOx treating catalyst:

$[H2 / TR]d > [H2 / TR]u$ ...(1)

$[H2 / TR]d \geq 0.3$ ...(2)

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas

passageway upstream of said hydrogen enriching device and combustion gas in a state before undergoing the hydrogen ratio increasing by said hydrogen enriching [means] device; and [H2 /TR]d is a ratio between a concentration [H2]d of hydrogen and concentration [TR]d of total reducing components in exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and downstream of said hydrogen enriching device, and wherein the hydrogen enriching device produces hydrogen in the engine.

14 not generic Fig 3+4
15 not generic Fig. 2

16. (Once Amended) An exhaust gas purifying system as claimed in Claim 15, wherein the CO and HC selective oxidation catalyst further contains palladium and cerium oxide, the palladium being carried in an amount ranging from 20 to 80 % by weight of total palladium on cerium oxide.

not generic Fig. 2

(Fig. 2) 17 not generic
(Fig. 3) 18 not generic

19. (Once Amended) An exhaust gas purifying system [as claimed in Claim 18,] comprising:

a NOx treating catalyst for reducing NOx disposed in an exhaust gas passageway of a combustion device, to reduce NOx in presence of reducing components in exhaust gas; and

not generic

a hydrogen enriching device disposed upstream of said NOx treating catalyst with respect to flow of exhaust gas from the combustion device and arranged to increase a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas so as to meet relations represented by following formulae (1) and (2), when reduction of NOx is carried out by said NOx treating catalyst:

Fig. 2

[H2 / TR]d > [H2 / TR]u ...(1)

[H2 / TR]d ≥ 0.3 ...(2)

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas passageway upstream of said hydrogen enriching device and combustion gas in a state before undergoing the hydrogen ratio increasing by said hydrogen enriching device; and [H2 / TR]d is a ratio between a concentration [H2]d of hydrogen and a concentration [TR]d

of total reducing components in exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and downstream of said hydrogen enriching device,

wherein said hydrogen enriching device is a device for producing hydrogen in at least one of combustion gas and exhaust gas and includes a hydrogen producing catalyst containing at least one noble metal, wherein the hydrogen producing catalyst has a function to produce hydrogen from HC and CO in at least one of combustion gas and exhaust gas, and

wherein the hydrogen producing catalyst includes a first catalytic component for oxidizing HC and CO to decrease oxygen, said first catalytic component being disposed in a first section of the hydrogen producing catalyst, and a second catalytic component for producing hydrogen and disposed in a second section of the hydrogen producing catalyst, the second section being located downstream of the first section with respect to flow of exhaust gas, so that an amount of oxygen to be contacted with the second catalytic component is decreased.

(Fig. 2) 19 not generic
20 " "
21 " "
22 not generic
(Fig. 2) 23
24 generic
25 "
26 "
27 "

28. (Once Amended) An exhaust gas purifying system comprising:

a NOx treating catalyst for reducing NOx disposed in an exhaust gas passageway of a combustion device, to reduce NOx in presence of reducing components in exhaust gas; and

generic

means for enriching hydrogen disposed upstream of said NOx treating catalyst with respect to flow of exhaust gas from the combustion device, said hydrogen enriching means is for increasing a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas so as to meet relations represented by the following formulae (1) and (2), when reduction of NOx is carried out by said NOx treating catalyst:

$[H2/TR]d > [H2/TR]u \ldots(1)$

$[H2 / TR]d \geq 0.3 \ldots(2)$

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas passageway upstream of said hydrogen enriching device and combustion gas in a state before undergoing the hydrogen ratio increasing by said hydrogen enriching means; and [H2 / TR]d is a ratio between a concentration [H2]d of hydrogen and a concentration [TR]d of total reducing components in exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and downstream of said hydrogen enriching [device] means, wherein said means for enriching hydrogen is at least one selected from the group consisting of a means for producing hydrogen in at least one of combustion gas and exhaust gas, a means for decreasing the reducing components other than hydrogen in at least one of combustion gas and exhaust gas, and a means for suppressing consumption of hydrogen in at least one of combustion gas and exhaust gas.

29. (Once Amended) A method of purifying exhaust gas from a combustion device provided with an exhaust gas purifying system including a NOx treating disposed in an exhaust gas passageway of the combustion device, [the] a NOx treating catalyst reducing NOx in presence of reducing components in exhaust gas, said method comprising:

increasing a ratio of hydrogen to total reducing components in at least one of combustion gas and exhaust gas to be supplied to the NOx treating catalyst so as to meet relations represented by the following formulae (1) and (2), when reduction of NOx is

generic carried out by said NOx treating catalyst:

$$[H2 / TR]d > [H2 / TR]u \ldots (1)$$

$$[H2 / TR]d \geq 0.3 \ldots (2)$$

where [H2 / TR]u is a ratio between a concentration [H2]u of hydrogen and a concentration [TR]u of total reducing components in at least one of exhaust gas in the exhaust gas passageway upstream of said hydrogen enriching [device] and combustion gas in a state before undergoing the hydrogen ratio increasing; and [H2 / TR]d is a ratio between a concentration [H2]d of hydrogen and a concentration [TR]d of total reducing components in

exhaust gas in the exhaust gas passageway upstream of the NOx treating catalyst and in a state after undergoing the hydrogen ratio increasing,

wherein said ratio of hydrogen to total reducing components is increased by at least one selected from the group consisting of producing hydrogen in at least one of combustion gas and exhaust gas, decreasing the reducing components other than hydrogen in at least one of combustion gas and exhaust gas, and suppressing consumption of hydrogen in at least one of combustion gas and exhaust gas.